

## THE LAND BIRDS OF SRIHARIKOTA ISLAND, SOUTHERN INDIA AND CONSERVATION ISSUES

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Surveys, censuses and mist-netting were carried out during 1976-1977, 1990-1994 and 2001-2008 to enumerate the land birds of Sriharikota Island, southern India. A total of 125 species of land birds were recorded comprising of 70 residents, 33 winter migrants and 12 seasonal migrants; the status of another 10 species is uncertain. An annotated checklist of these species is provided with special reference to their distribution in different habitat types. The White-rumped Vulture *Gyps bengalensis* has become locally extinct in the area. The conservation issues facing the Island, and especially the impact of plantations on the avifauna, are discussed and recommendations to mitigate these addressed.

**Key words:** Sriharikota, land birds, conservation issues, plantations, invasives

### INTRODUCTION

Sriharikota Island in the south-eastern coast of India is important from the biodiversity point of view as it has the last remaining, largest and best-preserved tracts of coastal Tropical Dry Evergreen Forest in India (Meher Homji 1974; Suryanarayana *et al.* 1989, 1998). The Island serves as the spaceport of India and has been under the administration of the Indian Space Research Organization (ISRO) since 1969. The faunal and floral diversity of the Island is fairly well-documented through a number of research projects over the years. The first investigation of the avifauna of Sriharikota Island were surveys of 10 and 15 days undertaken by the Bombay Natural History Society (BNHS) during 1976 and 1977 respectively (BNHS 1977). This was followed by an in-depth study by the BNHS from 1990 to 1994 (Samant and Rao 1996; Rao 1998). Subsequent to this, data was collected on the birds (and other wildlife) of the Island through two other projects (Manakadan and Sivakumar 2004a; Manakadan *et al.* 2008). A paper on the waterbirds of the wetlands of the region was published from the investigations in Sriharikota island and from studies carried out in the adjoining Pulicat lake, besides other wetlands and heronries in the mainland (Kannan *et al.* 2008). In this paper, we provide an annotated checklist of the land birds of Sriharikota Island and also discuss the conservation issues facing land birds.

### STUDY AREA

Sriharikota is a spindle-shaped island (181 sq. km) situated in Nellore and Tiruvallur districts of Andhra Pradesh

and Tamil Nadu respectively. It is bounded on the east by the Bay of Bengal and on the north, south and west by the waters of Pulicat lake (Fig. 1). The Island comprises of low ridges of sand, marine and aeolian in origin, rising 4.5-6.0 m above msl and sloping from west to east. The water table is c. 2 to 5 m. Sriharikota has been connected by road to Sullurpet (18 km) on the mainland since 1970.

The rainfall is largely from the North-East Monsoon (October-December). Some rainfall is also received from the South-West Monsoon (June-September). The area is prone to cyclones, usually in the early part of May and October, during the onset of the two monsoons. The annual rainfall is c. 1,200 mm. December to February is the winter season, with temperatures being as low as 10 °C. March to September is the summer season with temperatures soaring over 40 °C. Relative humidity is lowest during May (18%), while the maximum (99%) is recorded during October.

Prior to the takeover of the Island by the Indian Space Research Organization (ISRO) between 1969 and 1972, there were around 20 villages on the Island with a total population of around 10,000 individuals. At present, besides the establishments of the Satish Dhawan Space Centre, SHAR (SDSC-SHAR), there are colonies established by ISRO for the former settlers and tribals of the Island, many of who work as labourers for ISRO. Access and movement on the Island is restricted. The SDSC-SHAR has a Conservation and Landscape Division for the conservation and management of the forests.

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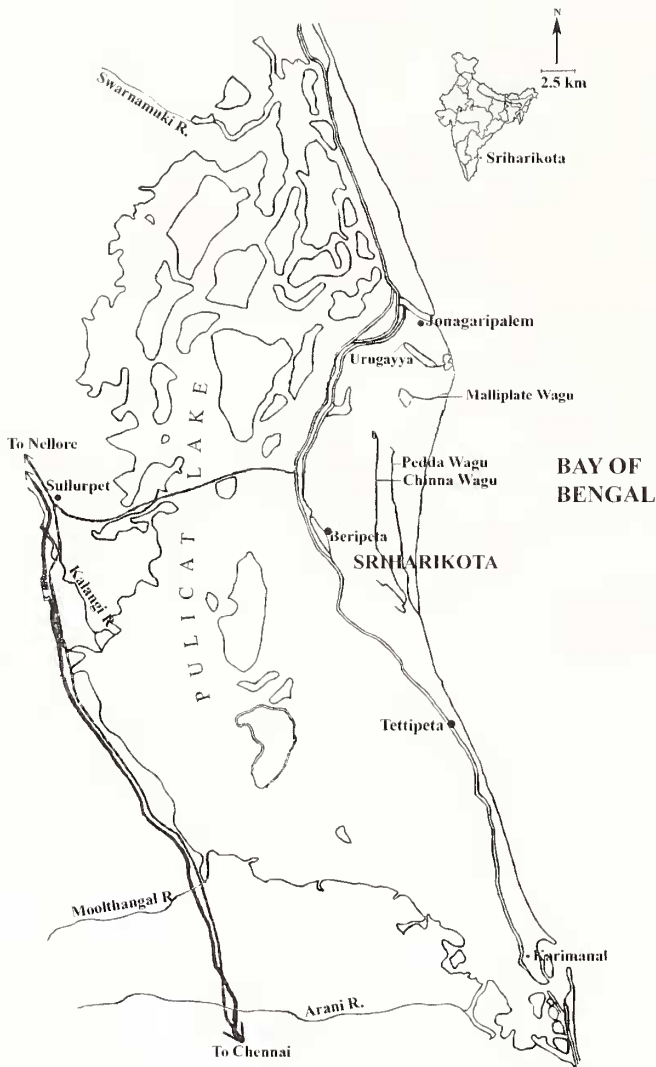


Fig. 1: Sriharikota Island and its adjoining areas

(TDEF) left in India. The forests had a long history of systematic clear-felling for fuel wood and timber starting with the British Era. Plantations of Eucalyptus (*Eucalyptus* spp.), Casuarina (*Casuarina equisetifolia*) and Cashew (*Anacardium occidentale*) had been raised over the years by the Forest Department and settlers, now covering approximately more than 20% of the landmass. After the establishment of the SDSC-SHAR in 1969, its Conservation and Landscape Division (C & LD) continued raising these plantations for quick afforestation of bare or degraded areas, creation of shelter belts, and revenue and work generation for the tribals. *Acacia auriculiformis* was also introduced on a small scale in the 1970s by the C & LD. The invasive Chilean Mesquite *Prosopis chilensis* has proliferated in some areas, especially along the western edge of the Island that borders Pulicat lake, and towards the extreme southern parts of the Island. Another invasive species, Cane *Calamus rotang*, introduced during the late 19<sup>th</sup> century by the British, has colonised the edges of

freshwater bodies and courses. Patches of abandoned coconut, tamarind, mango and palmyra (overgrown with native vegetation) planted by the former settlers are seen, especially in the southern tracts of the Island. Besides these, there are extensive grasslands with scattered shrubs or trees in the southern part of the island, and remnants of mangrove and salt marsh vegetation along the western edge of the Island.

The recorded fauna of this Island, other than birds, is represented by 27 mammal species, 12 species of amphibians, 34 species of reptiles, 44 species of fish and 51 species of butterflies. The mammals include the endangered Slender Loris *Loris lydekkerianus*, Jungle Cat *Felis chaus*, Rusty Spotted Cat *Prionailurus rubiginosus*, Bonnet Macaque *Macaca radiata*, Golden Jackal *Canis aureus*, Small Indian Civet *Viverricula indica* and the Indian Flying Fox *Pteropus giganteus*. The southern part of the Island has feral cattle (both buffaloes and cows) and a small population of feral horses (Anon 1908; Champion and Seth 1968; Meher Homji 1974; Reddy 1981, 1983; Agrawal *et al.* 1985; Suryanarayana *et al.* 1989, 1998; Manakadan and Sivakumar 2004a,b,c; Sivakumar and Manakadan 2004; Sivakumar *et al.* 2004; Manakadan *et al.* 2004).

**METHODS**

This paper is based on findings of different workers who carried out field investigations on the land birds of Sriharikota from data obtained through surveys, systematic censuses, bird banding and specific studies (BNHS 1977; Samant and Rao 1996; Rao 1998; Manakadan and Sivakumar 2004a; Manakadan *et al.* 2008). The species account is largely based on the findings of two major projects: i) Samant and Rao (1996), Rao (1998) and ii) Manakadan and Sivakumar (2004a) as more intensive studies were carried out under these projects. Between these two studies, the first project was totally focused on birds with systematic census, bird banding and habitat studies undertaken. The second project was a part of an overall faunal inventory project of the Island and without bird banding, and thus was less intensive in data collection. The study by David *et al.* (2008) was also long-term and intensive, but was confined to frugivores. Thus, records of the other surveys/studies (BNHS 1977; David *et al.* 2008) and unpublished records (V. Santharam, Patrick David and B. Senthil Murugan) are discussed only if significant.

**RESULTS**

The status, distribution and abundance of 125 species of land bird species of Sriharikota, with the English and scientific names following Rasmussen and Anderton (2005) are discussed below:



**Status:** R = Resident, with or without breeding records. WM = Winter Migrant: A species that breeds in the Palaearctic region/Himalayas during spring and 'winters' in the Indian subcontinent. SM = Seasonal Migrant: An 'Indian species' that occurs seasonally in the area. ? = Status Uncertain

**Abundance:** VC = Very Common: Sightings possible on almost all days in a year/season in suitable habitats. C = Common: Sightings of about once a week in a year/season in suitable habitats. O = Occasional: About one sighting fortnight/month in a year/season in suitable habitats. Ra = Rare: Less than 5 sightings per year or 3 sightings a season. VRa = Very Rare: Record based on only 1 or 2 sighting. VRa/O = Species recorded to be very rare during the earlier studies but was occasionally recorded during the later studies; and corresponding inferences for variations of these (e.g., O/VRa, C/VRa).

#### 1. **Black Baza** *Aviceda leuphotes* (WM VRa)

The only records of the Black Baza were by Patrick David (unpublished data), who sighted two birds on November 12 and 14, 2007, and on February 06, 2008. The birds were sighted in the stretch between 'STEX' and 'PSLV', near the culvert over the Pedda Vagu. The second sighting was close to the first site and the third sighting was about 200 m from the first two sighting areas, all indicating that the sightings were of the same pair.

#### 2. **Oriental Honey-Buzzard** *Pernis ptilorhyncus* (R C)

Rao (1998) found the Oriental Honey-Buzzard to be fairly common on the Island in well-wooded areas and particularly near eucalyptus plantations at Keepakam. Manakadan and Sivakumar (2004a) recorded the species only in TDEF and eucalyptus plantations.

#### 3. **Black-winged Kite** *Elanus caeruleus* (R O)

Rao (1998) obtained only one sighting of the Black-winged Kite in an open grassy patch near Beripeta on August 20, 1990, but found it to be fairly common in agricultural fields on the mainland near Sullurpet. Manakadan and Sivakumar (2004a) recorded the species on a few occasions only in open scrub during summer. The species would probably be more common in the grassland areas in the southern part of the Island, which was rarely surveyed due to difficult logistics.

#### 4. **Black Kite** *Milvus migrans* (R VRa)

The only record of the Black Kite in Sriharikota is of a bird in August 1990 near Kothachenu close to Pulicat lake (Rao 1998). This species, which inhabits towns and cities (Ali and Ripley 1987; Rasmussen and Anderton

2005), is also not common in the small towns on the mainland.

#### 5. **White-rumped Vulture** *Gyps bengalensis* (R O/Extinct)

The first survey (BNHS 1977) discussed the White-rumped Vulture as 'soaring over many parts of the Island'. Rao (1998) recorded around 75-100 birds nesting on tall *Tamarindus indica* trees between November and March near Kodaledu. The largest flock size sighted by Manakadan and Sivakumar (2004a) consisted of 13 birds; all the other sightings consisted of 1-3 birds. Only one (unsuccessful) case of nesting was recorded during 2001. The birds disappeared towards the end of 2003 and have probably become locally extinct (see Discussion)

#### 6. **Short-toed Eagle** *Circaetus gallicus* (R VRa)

The only record of the Short-toed Eagle was by Manakadan and Sivakumar (2004a), who sighted a pair in the western stretch of Fireline-12 in August 2003. Along with the characteristic 'piuu-piiuu' calls (Ali and Ripley 1987), the birds soared overhead for sufficient time to confirm identification. The status of the species is uncertain and the birds could be more common in the southern grassland areas of the Island (which was rarely visited) as it is partial to open habitats (Ali and Ripley 1987; Rasmussen and Anderton 2005).

#### 7. **Crested Serpent-Eagle** *Spilornis cheela* (R Ra)

Rao (1998) recorded the Crested Serpent-Eagle only twice from eucalyptus plantations near Keepakam. Manakadan and Sivakumar (2004a) did not record the species during their study, nor was the species recorded during the first BNHS survey (BNHS 1977). However, Senthil Murugan (unpublished data) recorded it occasionally from 2004 to 2008.

#### 8. **Pallid Harrier** *Circus macrourus* (WM Ra)

Rao (1998) obtained only two sightings of the Pallid Harrier: one bird on February 01, 1990, from Ravanappa Chatram and another on March 05, 1992, soaring over Keepakam. Santharam (unpublished data) saw a male on the Island in February 1990. Manakadan and Sivakumar (2004a) obtained only one sighting of a bird flying over Pulicat lake and heading towards Sriharikota in February 2003, and Patrick David (unpublished data) recorded the species once on the Island. The species could probably be more common in the grassland areas in the southern part of the Island, which was rarely surveyed due to difficult logistics.

#### 9. **Shikra** *Accipiter badius* (R O)

The Shikra was occasionally sighted in TDEF forest and plantations by all the workers.

10. **Besra Sparrowhawk** *Accipiter virgatus* (WM VRa)

The only record of the Besra Sparrowhawk in Sriharikota is through a solitary individual ringed on February 27, 1991, from Keepakam. The species is known to winter in the Eastern Ghats (Ali and Ripley 1987; Rasmussen and Anderton 2005).

11. **White-eyed Buzzard** *Butastur teesa* (R O)

The White-eyed Buzzard was occasionally seen throughout the Island mostly in an open scrub habitat and at the edges of the forests and plantations.

12. **Common Kestrel** *Falco tinnunculus* (WM O)

The Common Kestrel was occasionally recorded in coastal sand dune areas, open scrub and the southern grassland areas during winter. The species would probably be more common in the open grassland areas in the southern part of the Island, which was rarely surveyed due to difficult logistics.

13. **Amur Falcon** *Falco amurensis* (WM VRa)

The Amur Falcon was recorded only on two occasions: a male in open scrub in November 2002 and a flock of five birds actively hunting dragonflies along casuarina plantations adjoining the seashore in May 2003 (Sivakumar and Manakadan 2006). Records of the Amur Falcon in Andhra Pradesh are rare, being known from only two old records, one from Nellore and another from Rajamundry (Ali and Ripley 1987).

14. **Peregrine Falcon** *Falco peregrinus* (WM VRa)

The Peregrine Falcon (race: *calidus*) was recorded only once flying low near coastal sand dunes in the Chandrasikuppam area on November 02, 1990.

15. **Grey Francolin** *Francolinus pondicerianus* (R C)

The Grey Francolin is a common species in Sriharikota, but restricted to open scrub habitat. The species is likely to be more common in the southern grassland-open scrub areas.

16. **Blue-breasted Quail** *Coturnix chinensis* (R/SM? VRa?)

The only record of the Blue-breasted Quail is by Manakadan and Sivakumar (2004a) who sighted a party of three birds near the STEX Gate in June 2003. Being secretive and small ground dwelling species, quails easily escape notice and may be more common than recorded. Rasmussen and Anderton (2005) describe the species status in the Indian region as 'largely resident, but movements require further study'.

17. **Red Spurfowl** *Galloperdix spadicea* (R VRa)

Rao (1998) obtained only one sighting of a pair of Red

Spurfowl in scrub vegetation in the Ravanappa Chatram area. Manakadan and Sivakumar (2004a) recorded it only once (two birds) in TDEF forest.

18. **Grey Junglefowl** *Gallus sonneratii* (R VC)

The Grey Junglefowl is the commonest galliform species on the Island, occurring in almost all the forested areas of the Island. Manakadan and Sivakumar (2004a) located two nests in casuarina plantation, and Patrick David and Senthil Murugan (unpublished data) recorded a nest in TDEF forest.

19. **Yellow-legged Buttonquail** *Turnix tanki* (R VRa)

The only record of the Yellow-legged Buttonquail is a female ringed on March 27, 1990, from scrub forest in the north-east part of the Island. Buttonquails due to their small size and secretive nature easily escape notice and may be more common than recorded.

20. **Barred Buttonquail** *Turnix suscitator* (R VRa)

Rao (1998) recorded the Barred Buttonquail occasionally in open scrub forest having short grass patches. Manakadan and Sivakumar (2004a) did not record the species.

21. **Lesser Florican** *Syphoites indicus* (SM? VRa)

The Lesser Florican was not recorded by BNHS workers, but Rao (1998) mentions of a possible sight record in 1988 by K.R. Seetharaman (former Head, Photography Division) from a grassy patch at Beripeta. There is a very old record of the existence of the threatened Lesser Florican from the Chennai area (Ali and Ripley 1987), c. 80 km south. The nearest known recent wintering site (with breeding recorded for one year) for the species is Rollapadu Wildlife Sanctuary, Kurnool district, Andhra Pradesh (Sankaran and Manakadan 1990; Manakadan and Rahmani 1999), c. 300 km north of Sriharikota. Suitable habitat for the Lesser Florican is available in the grassland areas to the south of the Island, which was rarely visited due to difficult logistics.

22. **Yellow-wattled Lapwing** *Vanellus malabaricus* (R Ra)

Rao (1998) recorded three Yellow-wattled Lapwings on August 21, 1990, at a grassy patch near Beripeta. The earlier BNHS survey (BNHS 1977) had recorded the species once and Manakadan and Sivakumar (2004a) recorded the species on two occasions. The species could probably be breeding in the undisturbed southern grassland areas.

23. **Indian Stone-Curlew** *Burhinus indicus* (R O)

The Indian Stone-Curlew was occasionally recorded in open scrub and grassy patches near Beripeta, and often



flushed under cashew bushes. Calls were also heard in the late evenings from Kothachenu and the surrounding scrub.

**24. Rock Pigeon *Columba livia* (R C)**

The Rock Pigeon is a common species occurring mostly around buildings in the Island and near housing colonies, avoiding forested areas.

**25. Oriental Turtle-Dove *Streptopelia orientalis* (R/SM O)**

Rao (1998) occasionally recorded the Oriental Turtle-Dove from scrub areas in the Island during different times of the year, and more frequently near open scrub patches in Beripeta. Manakadan and Sivakumar (2004a) had a sighting of five birds around a waterhole in June 2002 and also recorded the species once each during census in TDEF and casuarina plantation. Patrick David and Senthil Murugan (unpublished data) obtained several sightings during 2007.

**26. Laughing Dove *Streptopelia senegalensis* (R Ra)**

Rao (1998) obtained a few sightings of the Laughing Dove mostly in scrub forest near Kodaledu and once near Beripeta in short grass. Manakadan and Sivakumar (2004a) recorded the species only once along the road adjoining the Buckingham Canal during March 2003. Patrick David and Senthil Murugan recorded the species regularly during their visits for study to the same area. The species is probably disappearing from areas inside the Island with the abandonment of villages and afforestation as it is partial to open scrub, village border environs and cultivation (Ali and Ripley 1987; Rasmussen and Anderton 2005).

**27. Spotted Dove *Streptopelia chinensis* (R VC)**

The Spotted Dove is the commonest dove on the Island, occurring in all localities including dense forest, open scrub and even plantations.

**28. Red Collared-Dove *Streptopelia tranquebarica* (R/SM VRa)**

Rao (1998) obtained a few sight records of the Red Collared-Dove during 1991, all from the Kodaledu scrub area. There are no other reports of the species on the Island.

**29. Orange-breasted Green-Pigeon *Treron bicinctus* (SM/R?)**

The Orange-breasted Green-Pigeon was not recorded during the first survey (BNHS 1977) and Rao (1998) obtained only two sightings from dense forest and scrub near Chandrasikuppam in November 1990. Manakadan and Sivakumar (2004a) recorded a small flock in January 2002 near Urugayya lake and again in March in the same area. David *et al.* (2008) recorded the species on a dozen occasions feeding in flocks on *Ficus* spp. fruits.

**30. Rose-ringed Parakeet *Psittacula krameri* (R VC)**

The Rose-ringed Parakeet is widely distributed over most areas of the Island, but is more common in the abandoned village forest areas, nesting in dead palm trunks.

**31. Plum-headed Parakeet *Psittacula cyanocephala* (SM VRa)**

Rao (1998) recorded the Plum-headed Parakeet in overhead flight and only from calls on a few occasions. It was recorded only once in overhead flight over casuarina plantation by Manakadan and Sivakumar (2004a). The only sight record was of a flock by Santharam (unpublished data) in April 1990. Judging from the few records, the species is probably a visitor from the Eastern Ghats.

**32. Greater Coucal *Centropus sinensis* (R C)**

The Greater Coucal is fairly common, occurring almost throughout the island, often seen foraging on ground near roads in a grassy patch. A nest was recorded on *Syzygium cumini* tree at a height of 7 m near Kodaledu.

**33. Blue-faced Malkoha *Phaenicophaeus viridirostris* (R C)**

The Blue-faced Malkoha is fairly common in all areas of the Island and is partial to thorny scrub habitat and bushes up to 3-4 m.

**34. Chestnut-winged Cuckoo *Clamator coromandus* (WM Ra)**

Rao (1998) obtained only two sight records of the Chestnut-winged Cuckoo in winter from dense thorny scrub near Kodaledu (December 1990) and Pedda Vagu (November 1991). Santharam (unpublished data) obtained a sighting during March 1990. Manakadan and Sivakumar (2004a) obtained only two sightings of single birds in January 2002 and February 2004 in TDEF forest.

**35. Jacobin Cuckoo *Clamator jacobinus* (R/SM O/Ra)**

Rao (1998) recorded the Jacobin Cuckoo occasionally in many areas, but especially in dense scrub patches. An albino was recorded in June 1991. However, Manakadan and Sivakumar (2004a) rarely recorded the species. Patrick David and Senthil Murugan (unpublished data) recorded the species only once during their study.

**36. Asian Koel *Endynamys scolopaceus* (R C)**

The Asian Koel occurs in dense forests and particularly around large fruiting trees like *Ficus*, abundant in abandoned village forest.

**37. Grey-bellied Cuckoo *Cacomantis passerinus* (SM Ra)**

Rao (1998) described the status of the Grey-bellied Cuckoo as 'hardly seen but presence mainly noted through

ringed individuals in winter', most caught from dense scrub patches at Kodaledu and Ravanappa chatram. Santharam (unpublished data) recorded the species thrice between February and April 1990. A bird (dark phase) was recorded by Manakadan and Sivakumar (2004a) in shrub vegetation in January 2002 in the central part of the Island. Patrick David (unpublished data) recorded a solitary bird in the Mavalam Wagu area in May 2007. The species is 'resident' in the Eastern Ghats (Ali and Ripley 1987; Rasmussen and Anderton 2005).

**38. Fork-tailed Drongo-Cuckoo *Surniculus (Ingubris) dicrnuoides* (SM VRa)**

The only record of the Fork-tailed Drongo-Cuckoo is by Senthil Murugan (unpublished data), who recorded a solitary bird on November 22, 2006, in open tall forest in the abandoned village forest south of Jonagipallam. The species is 'a resident' in the Eastern Ghats (Ali and Ripley 1987; Rasmussen and Anderton 2005).

**39. Common Hawk-Cuckoo *Hierococcyx varius* (R O)**

The Common Hawk-Cuckoo presence was mainly recorded through its calls, mostly in forest habitats, except casuarina plantations.

**40. Small Cuckoo *Cuculus poliocephalus* (WM VRa)**

Rao (1998) recorded the Small Cuckoo only once on May 10, 1990, from cashew plantations near sand dunes in the northern part of the Island presumably on return migration. Manakadan and Sivakumar (2004a) recorded a bird (in hepatic phase) in open scrub between PSLV I and II in April 2003.

**41. Common Barn-Owl *Tyto alba* (R Ra)**

Rao (1998) obtained only a few sightings of the Common Barn-Owl, mostly from abandoned village forest areas. Manakadan and Sivakumar (2004a) recorded it only once (in casuarina plantation).

**42. Indian Scops-Owl *Otus bakkamoetia* (R VRa)**

The occurrence of the Indian Scops-Owl in Sriharikota is not fully established with two brief sightings in abandoned village forest areas (Rao 1998).

**43. Indian Eagle-Owl *Bubo bengalensis* (R VRa)**

The record of the Indian Eagle-Owl is based only on a call heard by Rao (1998) once from a palmyra grove near swampy fields at Peddarettamala in March 1990.

**44. Mottled Wood-Owl *Strix ocellata* (R VRa)**

The presence of the Mottled Wood-Owl is known only from a juvenile ringed from Peddarettamala in March 1990

(Rao 1998). Manakadan and Sivakumar (2004a) sighted a pair in the Kothachenu area, where the pair was resident.

**45. Spotted Owlet *Athene braua* (R O)**

The Spotted Owlet was occasionally recorded in open scrub forest and around human habitation.

**46. Indian Jungle Nightjar *Caprimulgus iudicus* (R C)**

Manakadan and Sivakumar (2004a) recorded the calls of the Indian Jungle Nightjar frequently in TDEF and eucalyptus plantations during night surveys. The calls heard were *chuck chuck chuck*, sometimes ending with *wowo, wowo, wowo*, the call reported from Sri Lanka (Ali and Ripley 1987).

**47. Indian Little Nightjar *Caprimulgus asiaticus* (R O)**

Manakadan and Sivakumar (2004a) recorded the calls of the Indian Little Nightjar occasionally during visits to open scrub areas during night surveys.

**48. Savanna Nightjar *Caprimulgus affinis* (WM VRa)**

The record of the Savanna Nightjar is based only from a road kill in December 1990 near Kothachenu (Rao 1998).

**49. Little Swift *Apus affinis* (R O)**

The Little Swift was only recorded around residential colonies, but not in the forest areas.

**50. Asian Palm-Swift *Cypsiurus balasiensis* (R VC)**

The Asian Palm-Swift occurs throughout the island, and is more abundant in areas that have palmyra *Borassus flabellifer* palms.

**51. Little Green Bee-eater *Merops orientalis* (R C)**

The Little Green Bee-eater was mainly recorded in open scrub habitat throughout the Island, and is probably more common in the southern grassland areas.

**52. Blue-tailed Bee-eater *Merops philippinus* (WM O)**

The Blue-tailed Bee-eater, which arrives by October each year and departs by March, is more common in open areas at the edge of forests and plantations.

**53. Indian Roller *Coracias benghalensis* (R C)**

The Indian Roller frequents open scrub areas, particularly in the western side of the Island. It could also be more common in the southern grassland-open scrub areas.

**54. Common Hoopoe *Upupa epops* (R O)**

The Common Hoopoe was mostly recorded in open scrub areas and abandoned village forest.



55. **Coppersmith Barbet** *Megalaima haemacephala* (R O)

The Coppersmith Barbet is largely confined to the abandoned village forest, which has an abundance of *Ficus* trees. In the rest of the Island, it is found mainly where *Ficus* trees occur, and sometimes on fruiting trees of *Syzygium cumini*.

56. **Black-rumped Flameback** *Dinopium benghalense* (R O)

The Black-rumped Flameback was recorded mostly in well-wooded areas of the Island, including plantations.

57. **Indian Pitta** *Pitta brachyura* (SM C/Ra)

Rao (1998) found the Indian Pitta to be a fairly common winter visitor. He saw and heard its calls from many areas in the northern and central parts of the Island in dense scrub forest. Manakadan and Sivakumar (2004a) obtained only one record from the edge of a casuarina plantation bordering scrub.

58. **Jerdon's Bushlark** *Mirafra affinis* (R O)

Rao (1998) obtained only a few records of the Jerdon's Bushlark in open grass patches near Beripeta and Chengalapalem, with one ringed around Chengalapalem. Manakadan and Sivakumar (2004a) recorded it occasionally in open scrub and young cashew plantations with low ground cover.

59. **Ashy-crowned Finch-Lark** *Eremopterix griseus* (R O/C)

The Ashy-crowned Finch-Lark was only occasionally recorded in the central and northern open sandy areas of the Island, but was a common species in the southern grassland areas.

60. **Oriental Skylark** *Alauda gulgula* (R C/O?)

Rao (1998) found the Oriental Skylark to be common in open grass patches as well as around dried waterbodies of Chengalapalem, Pedda Vagu and some other areas. Manakadan and Sivakumar (2004a) recorded the species only once in the dried-up backwaters of Pulicat lake near Beripeta. The species could probably be more common in the southern grassland areas of the Island, which was rarely visited due to difficult logistics.

61. **Barn Swallow** *Hirundo rustica* (WM O)

The Barn Swallow arrives by mid-August and departs by March. Large numbers were seen on the Sriharikota-Sullurpet road in November by Rao (1998) and by Manakadan and Sivakumar (2004a) along with the Red-rumped Swallow *Hirundo daurica*.

62. **Red-rumped Swallow** *Hirundo daurica* (WM VRa)

The only records of the Red-rumped Swallow in the

Island are by Santharam (unpublished data), who sighted a few birds in flight during February and April 1990. However, huge flocks were seen perching on wires along the Sriharikota-Sullurpet road during winter as discussed under Barn Swallow.

63. **Wire-tailed Swallow** *Hirundo smithii* (R/SM VRa)

The Wire-tailed Swallow was only recorded by Rao (1998), who obtained a few sightings from Kothachenu of small flocks of up to eight birds perched on telegraph wires.

64. **Forest Wagtail** *Motacilla indicus* (WM O)

The Forest Wagtail was regularly sighted from TDEF forest and *Prosopis chilensis* forest and also ringed from Keepakam during winter. Some sightings were in late April and the first week of May.

65. **Paddyfield Pipit** *Anthus rufulus* (R C)

The Paddyfield Pipit occurs mainly on the western side of the island near open scrub and grassy patches at Chengalapalem and it is common in the southern grassland areas.

66. **Large Cuckooshrike** *Coraciina macei* (SM VRa)

Rao (1998) obtained a few sightings of the Large Cuckooshrike from tall mixed forest dominated by palms near Peddarettamala in November 1990. Manakadan and Sivakumar (2004a) sighted only one bird in eucalyptus plantation in February 2003 during their study. Patrick David and Senthil Murugan did not record the species.

67. **Black-headed Cuckooshrike** *Coraciina melanoptera* (WM O)

The Black-headed Cuckooshrike was occasionally recorded from the central forest areas of the Island along the Pedda and Chinna vagus, Pallivedhi and Sabari colony (Rao 1998; Manakadan and Sivakumar 2004a).

68. **Ashy Minivet** *Pericrocotus divaricatus* (WM VRa)

Rao (1998) recorded two birds once from tall mixed forest at Peddarettamala on February 27, 1991. Santharam (unpublished data) obtained call and sight (a pair) records on three occasions during February 1990. Manakadan and Sivakumar (2004a) obtained only one record of six birds along the Pedda Vagu area on the Zero Point – PSLV road during February 2003. The species has been reported from Chennai (Santharam 1990), c. 80 km south of Sriharikota. The Ashy Minivet which breeds in NE Asia and winters in SE Asia is a 'winter straggler' to the Indian region (Ali and Ripley 1987;

Rasmussen and Anderton 2005). The occurrence of the Ashy Minivet in Sriharikota and Chennai (=Madras) repeatedly (Santharam 1990) suggests that it is perhaps a regular but scarce winter visitor to the east coast of India.

**69. Small Minivet *Pericrocotus cinnamomeus* (V VRa)**

The only record of the Small Minivet in Sriharikota is by Patrick David (unpublished data) who recorded a solitary bird hunting for insects in dense forest at Keepakam on June 06, 2006.

**70. Common Woodshrike *Tephrodornis pondicerianus* (R C)**

The Common Woodshrike is a fairly widespread species, but rather rare in TDEF forest. It prefers thorny scrub patches and eucalyptus plantations, and in TDEF where eucalyptus trees were present.

**71. Asian Paradise Flycatcher *Terpsiphone paradisi* (SM O)**

The Asian Paradise Flycatcher is occasionally seen in Sriharikota in a variety of habitats, including dense forest groves. It occurs throughout winter and occasionally in summer.

**72. Black-naped Blue Monarch *Hypothymis azurea* (SM Ra)**

There are only a few records of the Black-naped Blue Monarch in Sriharikota with a bird ringed on March 20, 1990, at Beripeta. Manakadan and Sivakumar (2004a) and Patrick David (unpublished data) recorded the species only once during their studies.

**73. Red-whiskered Bulbul *Pycnonotus jocosus* (R VC)**

The Red-whiskered Bulbul is very common throughout the Island. In winter, large flocks congregate around eucalyptus blooms for nectar.

**74. Red-vented Bulbul *Pycnonotus cafer* (R C)**

The Red-vented Bulbul is less common than the other two bulbul species and is more partial to open scrub habitat.

**75. White-browed Bulbul *Pycnonotus luteolus* (R VC)**

The White-browed Bulbul is a very common species, more frequently heard than seen in dense scrub patches.

**76. Common Iora *Aegithina tiphia* (R VC)**

The Common Iora is a very common species occurring all over the Island, but was more frequently recorded in dense scrub and TDEF forest. It breeds from March till August, during which males were seen in full breeding plumage.

**77. Brown Shrike *Lanius cristatus* (WM C)**

The Brown Shrike is a common winter visitor and was recorded throughout the Island with the races *cristatus* and *lucionensis* recorded; the latter less common. The race *lucionensis* was first ringed in April 1990 (Mohapatra and Santharam 1992) near the SDSC-SHAR temple area and subsequently three more were ringed from the Kodaledu area (Rao 1998). The race *cristatus* arrives by mid-September and departs by mid-May. The race *lucionensis* is known to winter mainly in the Andaman Islands, but in recent years, they have been sighted increasingly in peninsular India (Mohapatra and Santharam 1992).

**78. Bay-backed Shrike *Lanius vittatus* (WM Ra)**

The Bay-backed Shrike was mostly recorded in the southern part of the Island having open scrub and sandy areas.

**79. Long-tailed Shrike *Lanius schach* (WM Ra)**

Rao (1998) recorded the Long-tailed Shrike infrequently with a few sightings from scrub habitat near the hospital and Mavalam Vagu areas. Manakadan and Sivakumar (2004a) did not record the species during their study.

**80. Orange-headed Thrush *Zoothera citrina* (WM Ra)**

The Orange-headed Thrush is an uncommon winter visitor, with both the races recorded. It prefers heavy undergrowth in TDEF forest.

**81. Asian Brown Flycatcher *Muscicapa daurica* (WM O)**

The Asian Brown Flycatcher is a widespread winter visitor though not common. Rao (1998) recorded individuals occasionally in the Kodaledu, Peddarettamala, Kothachenu areas and in the TDEF forest patches and ringed five birds between 1990-1992. Manakadan and Sivakumar (2004a) recorded the species in March 2003 in eucalyptus plantations and Patrick David and Senthil (unpublished data) recorded it during winter in many areas.

**82. Brown-breasted Flycatcher *Muscicapa muttui* (WM VRa)**

The presence of the Brown-breasted Flycatcher is known only from two individuals ringed in March 1991 from the Kothachenu area, possibly on return migration.

**83. Red-breasted Flycatcher *Ficedula parva* (WM VRa)**

The presence of the Red-breasted Flycatcher (race: *albicilla*) are known from a solitary female ringed on March 12, 1991, in dense *Prosopis chilensis* scrub at Keepakam and sightings of solitary birds by Santharam (unpublished data) and Manakadan and Sivakumar (2004a) during January 1990 and March 2003 respectively.



84. **Blue-throated Flycatcher** *Cyornis rubeculoides* (WM C)

The Blue-throated Flycatcher winters throughout the Island from mid-October to early April. The species was seen often in TDEF forest undergrowth, as well as in scrub habitat.

85. **Black Redstart** *Phoenicurus ochruros* (WM VRa)

Rao (1998) sighted the Black Redstart on a few occasions in scrub areas near Kodaledu and Kothachenu during winter. A female ringed was on February 10, 1992. The species was not recorded during the subsequent studies.

86. **Indian Blue Robin** *Luscinia brunnea* (WM VRa)

The Indian Blue Robin is known only through two birds ringed from dense scrub at Keepakam (April 03, 1990) and Beripeta (December 30, 1991), and is possibly a passage migrant.

87. **Oriental Magpie-Robin** *Copsychus saularis* (R C)

The Oriental Magpie-Robin is a common species in Sriharikota, occurring in scrub as well as TDEF forest.

88. **White-rumped Shama** *Copsychus malabaricus* (R C)

The White-rumped Shama occurs throughout the Island, but only where there is dense forest cover or dense patches.

89. **Indian Black Robin** *Saxicoloides fulicatus* (R Ra)

The Indian Black Robin is not a common species in Sriharikota, recorded only occasionally in scrub areas at Kodaledu, Kothachenu, Peddarettamala and Mavalam Vagu, all of which were former village areas.

90. **Yellow-billed Babbler** *Turdoides affinis* (R C)

The Yellow-billed Babbler is common in the Island and recorded occasionally in gardens in residential areas. The species is brood parasitized by the Jacobin Cuckoo.

91. **Yellow-eyed Babbler** *Chrysomma sinense* (SM? VRa)

The only record of the Yellow-eyed Babbler in Sriharikota is by Santharam (unpublished data), who heard its call during February 1990 and sighted a bird in March 1990 near the STEX area.

92. **Zitting Cisticola** *Cisticola juncidis* (R O)

The Zitting Cisticola is mostly seen in the north-east areas in open scrub and grass patches. It could probably be more common in the southern grassland areas.

93. **Grey-breasted Prinia** *Prinia hodgsonii* (R Ra)

Rao (1998) recorded the Grey-breasted Prinia on a few occasions from short grass and scrub near Kodaledu and

towards the coast and did not see it elsewhere in the Island. The species could probably be more common in the southern grassland areas.

94. **Plain Prinia** *Prinia inornata* (R Ra)

The Plain Prinia was recorded in areas of dense grass near Kodaledu and in open scrub patches near Ravanappa Chatram by Rao (1998). The species could probably be more common in the southern grassland areas.

95. **Common Tailorbird** *Orthotomus sutorius* (R VC)

The Common Tailorbird is a very common species, occurring in most areas of the Island.

96. **Thick-billed Warbler** *Acrocephalus aedon* (WM VRa)

Rao (1998) records two Thick-billed Warblers from Kodaledu in December 1989 and January 1992. Santharam (unpublished data) and Manakadan and Sivakumar (2004a) recorded solitary birds during March 1990 and February 2002 respectively.

97. **Blyth's Reed-Warbler** *Acrocephalus dumetorum* (WM C)

The Blyth's Reed-Warbler was frequently recorded during winter over a variety of habitat types and particularly in TDEF. It arrives soon after the onset of the North-east monsoon and departs by the end of April. The site fidelity was recorded in the species with banded birds returning to the same site during subsequent winters.

98. **Indian Reed-Warbler** *Acrocephalus (stentoreus) brunnescens* (WM VRa)

The record of the Indian Reed-Warbler is known from two birds ringed in Chengalapalem during January 1990. The species could be more common in the reed beds around Katangayya Lake and the upper reaches of the Mavalam or Malliplatte Vagu.

99. **Greenish Warbler** *Phylloscopus trochiloides* (WM C/VRa)

Rao (1998) found the Greenish Warbler to be a widespread winter visitor in areas with good tree cover with records from late September to April. Birds were recorded to occupy the canopy of *Syzygium cumini* throughout winter and were also recorded in casuarina plantations. Manakadan and Sivakumar (2004a) did not record the species, but Senthil Murugan obtained frequent sightings during winter.

100. **Large-billed Leaf-Warbler** *Phylloscopus magnirostris* (WM Ra)

The Large-billed Leaf-Warbler was rarely recorded.

Two individuals ringed at Kodaledu (April 07, 1990) and Beripeta (April 30, 1991). Two birds were recorded on May 15, 1991, in *Albizia amara* forest near Beripeta. Manakadan and Sivakumar (2004a) recorded two birds in the PHC-II residential areas in January 2002.

**101. Lesser Whitethroat *Sylvia curruca* (WM Ra/C)**

Rao (1998) found the Lesser Whitethroat to be relatively uncommon in Sriharikota with a very few sight records and only ten individuals were ringed in three years mostly from dense scrub patches in Keepakam, Kodaledu, and Chengalapalem. However, Manakadan and Sivakumar (2004a) recorded the species frequently during census in winter, and the species was also recorded by Patrick David and Senthil Murugan

**102. Pale-billed Flowerpecker *Dicaeum erythrorhynchos* (R VC)**

The Pale-billed Flowerpecker has a widespread distribution in the Island. It is especially abundant in old plantations of casuarina due to the abundance of its food plant *Dendrophthoe falcata* (= *Loranthus longiflorus*) growing as a stem parasite on casuarina.

**103. Purple-rumped Sunbird *Leptocoma zeylouica* (R VC)**

The Purple-rumped Sunbird is the most common species of sunbird on the Island, occurring over a variety of habitats.

**104. Purple Sunbird *Cinnyris asiaticus* (R C)**

The Purple Sunbird was recorded in most parts of the Island, occurring in a variety of habitats. Patrick David (unpublished data) found it to be the least common among the three sunbirds species of the Island.

**105. Loten's Sunbird *Cinnyris lotenius* (R O)**

The Loten's Sunbird is widespread but is not as common as the other two sunbirds with a restricted presence on the Island (Rao 1998; Manakadan and Sivakumar 2004a).

**106. Indian Silverbill *Euodice malabarica* (R VRa)**

The Indian Silverbill was recorded during the first survey (BNHS 1977) at Beripeta near Buckingham canal, but not by Rao (1998). Manakadan and Sivakumar (2004a) obtained only one sighting of two birds on a casuarina tree in scrub forest near Urugayya lake in April 2004. Munias could possibly be more common in the southern grassland areas of the Island.

**107. White-rumped Munia *Louchura striata* (R VRa)**

The White-rumped Munia was recorded only during the first survey (BNHS 1977). Munias could possibly be more

common in the southern grassland areas of the Island.

**108. Tricoloured Munia *Louchura ualacca* (R VRa)**

The only record of the Tricoloured Munia was by Rao (1998), sighting of a flock of six birds from the Chandrasikuppam near the coast in November 1990. Munias could possibly be more common in the southern grassland areas of the Island.

**109. House Sparrow *Passer douesticus* (R VC/VRa)**

The House Sparrow was recorded throughout the year near human habitation, but was rarely seen in the forest.

**110. Yellow-throated Sparrow *Petrouia xanthocollis* (R O)**

The Yellow-throated Sparrow was occasionally recorded in scrub habitat at Beripeta and Kodaledu by Rao (1998) and in the Penubakkam area (Manakadan and Sivakumar 2004a). Besides occasional sightings, Patrick David and Senthil Murugan recorded a nest near the old launch pad.

**111. Baya Weaver *Ploceus philippinus* (R Ra)**

Rao (1998) recorded nests (with a male and three females) of the Baya Weaver hanging from a casuarina tree in dense evergreen scrub near Urugayya in September 1990. The species was also recorded by the first BNHS (1977) survey team in the Chinna Vagu, Beripeta and Mavalam Vagu areas. Manakadan and Sivakumar (2004a) did not record the species in the northern forested areas, but a few nests were once recorded during a survey of the southern grassland areas. Patrick David and Senthil Murugan (unpublished data) recorded them nesting in the Penubakkam area.

**112. Brahminy Starling *Teuueuuchus pagodarum* (SM Ra)**

Rao (1998) found the Brahminy Starling to be uncommon with 2-3 individuals noted occasionally from Mavalam Vagu, Beripeta and Kodaledu areas. A few sightings were also obtained in the Beripeta near cashew plantations. Manakadan and Sivakumar (2004a) sighted 10 birds in February 2002 near the PHC-I residential area and Patrick David and Senthil Murugan (unpublished data) recorded the species twice (Penubakkam and Urugayya areas).

**113. Rosy Starling *Sturnus roseus* (WM VRa/O)**

The Rosy Starling was not recorded during the first (BNHS 1977) and second surveys (Rao 1998). Manakadan and Sivakumar (2004a) first recorded it as large flocks feeding on the fruits of *Phoenix farinifera* in the southern grassland areas in March 2002. A few small flocks were occasionally sighted subsequently, including in residential areas. Large flocks roosting in mango trees in the residential areas during



December 2004. Patrick David and Senthil Murugan (unpublished data) obtained only one sighting: a flock in the southern area close to Karimanal.

**114. Common Starling *Sturnus vulgaris* (WM VRa)**

Rao (1998) obtained two possible sightings of the Common Starling in overhead flight near Peddarettamala and Kodaledu areas in flocks of 50 and 14 birds on February 17, 1992, and February 26, 1992, respectively. The record of the Common Starling in Sriharikota is one of the southernmost records for the distribution of species in India.

**115. Common Myna *Acridotheres tristis* (R VC)**

The Common Myna is one of the commonest land birds in Sriharikota, and was recorded in all the habitat types except casuarina and eucalyptus plantations.

**116. Indian Golden Oriole *Oriolus kundoo* (SM O)**

The Indian Golden Oriole is a winter visitor to the Island and occasionally seen from areas with good tree cover, and especially in abandoned village forest and residential areas. *Note:* We did not make attempts to confirm if the birds sighted were actually the Indian Golden Oriole or the very similar European Golden Oriole *O. oriolus*, as the two species were treated as conspecific till recently.

**117. Black Drongo *Dicrurus macrocercus* (R C)**

The Black Drongo is a common species in Sriharikota, occurring mostly in the TDEF forest as well as open scrub areas. The species breeds in Sriharikota.

**118. Ashy Drongo *Dicrurus leucophaeus* (SM Ra)**

Rao (1998) obtained a few sight records of the Ashy Drongo from the Beripeta area in winter with banding records of one bird each in Keepakam (March 12, 1991) and Beripeta (January 07, 1992). Manakadan and Sivakumar (2004a) recorded the species once at Kothachenu in January 2002.

**119. White-bellied Drongo *Dicrurus caernlescens* (SM VRa/O)**

Rao (1998) recorded the White-bellied Drongo only on a few rare occasions in dense thorny scrub and areas with tree cover at Kodaledu during December 1990. Manakadan and Sivakumar (2004a) did not record the species, but Patrick David and Senthil Murugan (unpublished data) recorded it on a number of occasions during winter, mainly feeding on nectar in eucalyptus plantations.

**120. Bronzed Drongo *Dicrurus aeneus* (SM VRa)**

The only record of the Bronzed Drongo in Sriharikota

is by Patrick David (unpublished data), who recorded a bird in open tall forest south of Jonagipallem on May 11, 2007.

**121. Hair-crested Drongo *Dicrurus hottentottus* (SM VRa)**

The first record of the Hair-crested Drongo in Sriharikota was by Manakadan and Sivakumar (2004a) and Sivakumar and Manakadan (2003) who sighted two birds at the edge of an eucalyptus plantation bordering the Pedda Vagu stream near Picheruvu Gunta during June 2002. Patrick David (unpublished data) recorded two birds in the same area during his study. The distribution of the Hair-crested Drongo is the Himalayan foothills, NE India and downwards to the Eastern and Western Ghats (Ali and Ripley 1987) However, there have been stray records outside these areas, i.e., Kutch (Himmatsinhji 1997), Hyderabad (Pittie 1997) and Point Calimere (Natarajan and Balasubramaniam 1990).

**122. Ashy Woodswallow *Artamus fuscus* (R C/O)**

Rao (1998) found the Ashy Woodswallow to be fairly common occurring in tall mixed forest dominated by palms. Manakadan and Sivakumar (2004a) recorded them occasionally around Urugayya lake, Malliplate Vagu and the Beripeta area.

**123. Rufous Treepie *Dendrocitta vagabunda* (R VRa/O)**

The Rufous Treepie species has not been recorded in the central and northern areas of the Island.

Its first record was of a pair near Karimanal in the southern part of the Island in March 2002 (Manakadan and Sivakumar 2004a). After that, the species was occasionally recorded during visits to the southern part of the Island (south of Tettipeta), where it probably breeds. Senthil Murugan heard its call in the southern part of the Island after Jonagipallem.

**124. House Crow *Corvus splendens* (R VC)**

The House Crow was recorded mostly frequenting housing and office areas, avoiding dense forest.

**125. Eastern Jungle Crow *Corvus (macrorhynchos) levaillantii* (R C)**

The Eastern Jungle Crow is a common species in all areas including human habitation, but also inhabits forests and scrub areas of the Island unlike the House Crow.

(Other than those listed above, the other bird species that are not typical waterbirds but are wetland dependent, namely fish-eagles, marsh-harrier, fish-owls, pratincoles, kingfishers and wagtails) also occur on the Island. For accounts on the species, see Kannan *et al.* (2008).

## DISCUSSION

### Profile of the land birds

The land birds recorded in Sriharikota Island comprise of (i) 70 resident species with or without breeding records (ii) 33 species of winter migrants from the Palaearctic region/Himalayas, (iii) 12 species of seasonal migrants coming either from the Eastern Ghats or other regions of India, and (iv) 10 species are of uncertain status due to paucity of records.

Even for some of the species classed as residents (e.g., Black-winged Kite, Short-toed Snake-Eagle, Oriental Turtle-Dove, Asian Koel, Wire-tailed Swallow), their status is uncertain due to few records or as these species were absent/scarse during certain periods/seasons in the Island, indicating that they are either visitors from surrounding areas or are species that periodically move out of the Island unlike the 'true residents', such as the three species of bulbuls and sunbirds among others, which are seen throughout the year. Similarly, the paucity of records for some of the winter migrants (e.g., Black Baza, Besra Sparrowhawk, Amur Falcon, Common Starling) and seasonal migrants (e.g., Blue-breasted Quail, Yellow-eyed Babbler, Fork-tailed Drongo-Cuckoo, Bronzed Drongo and Hair-crested Drongo) raises the question whether these species visit the Island only during certain years due to adverse habitat conditions in their usual wintering range (for migrants) and distributional range (in case of seasonal migrants) or these are cases of 'vagrants'. The occurrence of Eastern Ghats hill birds (e.g., Fork-tailed Drongo-Cuckoo, Bronzed Drongo, Hair-crested Drongo) or those that winter in the Ghats (e.g., Besra Sparrowhawk) in this coastal strip is not surprising as the hill ranges run parallel to the Island with some of the hills being only 50 km from Sriharikota. The Eastern Ghats and the forest of Sriharikota share a good number of plant species with Sriharikota except endemic species of tropical dry evergreen forest (Meher Homji 1974). The relatively undisturbed (no woodcutting and movement of people) forest in Sriharikota probably, attract these bird species to the Island.

As for the abundance of bird species, underestimates can be expected for small, secretive birds and especially ground birds, such as quails and buttonquails, and also nocturnal species such as owls and nightjars. Another bias is that the southern part of the Island was much less surveyed due to the distance and difficult logistics. This area is a mixture of grasslands, open scrub and sand dune vegetation, ideal habitats for birds that inhabit or prefer grasslands and open habitats, such as harriers, larks and pipits. Hence, such species could be more abundant in these areas, and thus in Sriharikota, than recorded.

### Changes in the avifauna

Some changes in the avifauna are apparent while comparing the observations of different workers, though these are not strictly comparable as the sampling effort and time varied considerably due to the nature of the studies. One of the most dramatic changes is the decline of the White-rumped Vulture with the birds now probably extinct in Sriharikota and the surrounding areas (see species account). In India, the *Gyps* vultures, have been facing a severe population decline in the past decade with more than 95% decline in some areas due to drug diclofenac given to cattle, on whose carcasses the vultures feed (Prakash *et al.* 2003).

Granivorous species such as munias and bayas also are likely to have undergone decline. Nests of the Baya Weaver were recorded in the Chinna Vagu, Beripeta and Malliplate Vagu by the first survey team (BNHS 1977) and on casuarina trees near Urugayya during the second study (Rao 1998). Manakadan and Sivakumar (2004a) did not record the species in the northern forested areas, but a few nests were once recorded during a survey in the southern grassland areas. The Baya, besides munias, have probably disappeared from the northern parts of the Island after cultivation stopped with the removal of the villages, as these species are primarily seedeaters and thrive around grassland and agricultural areas (Ali and Ripley 1987). It also appears that there has been a decline in species that are partial to open habitat (open scrub, grassy patches and around human habitation) in the central areas of Sriharikota due to the increase in forest cover, either naturally or aided by afforestation schemes. These species include the Red-vented Bulbul, Laughing Dove, munias and Baya Weaver. In the central densely forested area, these species were recorded largely in open scrub patches.

### Impact of plantations

Two studies carried out in Sriharikota (Rao 1998; Manakadan and Sivakumar 2004a) revealed that overall plantations result in pauperisation of bird fauna, which was further confirmed in a study on frugivorous birds (David *et al.* 1998). Among the plantations, species richness and abundance of birds was found to be higher in eucalyptus compared to casuarinas and cashew plantations. This was because eucalyptus plantations in Sriharikota have a good mix of the native vegetation, especially as an under-storey. In casuarina, the spacing between trees is narrow and the dense litter formation permits only sparse undergrowth. The most destructive plantation species to the native vegetation (and birdlife) is cashew with almost no other plant species surviving under mature cashew plantations due to its spreading nature.



Eucalyptus is attractive to nectar feeding birds like bulbuls, flowerpecker and sunbirds only during the flowering season. Even though nectar feeding bird densities (especially Pale-billed Flowerpecker) were also high in casuarina, this was due to the abundance of the parasitic plant *Dendrophthoe falcata* (= *Loranthus longiflorus*) on casuarina. *D. falcata* is a major food plant of the Pale-billed Flowerpecker, which also acts as a seed disperser for this parasite (Ali and Ripley 1987). *D. falcata* was also present in the other vegetation types, but was not as common as in casuarina plantations. Besides *D. falcata*, the presence of a fleshy-fruited species of climbers on the canopies of casuarina such as *Olax scandens* also attracted bird species. Besides the Pale-billed Flowerpecker, the only other species recorded in good numbers in plantations was the Common Woodshrike, almost restricted to eucalyptus. Even the records obtained of the species in natural forest were in areas that had an isolated patch of eucalyptus trees. The Common Woodshrike is partial to secondary forest (Ali and Ripley 1987), which may explain its relative abundance in eucalyptus plantations. A number of other studies have also shown that plantations, especially single-species ones, are detrimental to bird species (Gandhi 1986; Evans 1992; Fogarty and Vilella 2003).

A positive factor of the plantations in Sriharikota is that silvicultural practices as undertaken in commercial plantations such as high density planting, dead tree and weed removal, and short-rotation harvesting (8-10 years) are not practiced, as the plantations are raised primarily for afforestation and shelter-belts. Hence, most of the existing plantations are more than 20 years old and with a good mix of native vegetation. This has resulted in less severity of environmental conditions that occur in commercial plantations due to single species domination.

## CONSERVATION ISSUES

Though relatively well protected, the forests of Sriharikota also face threats, some of which have impacts on land birds.

### Plantations

The trend in India is that formations lacking in timber species are as a rule considered useless and felled or replaced by plantations, little realising that these have rich diversity and are repositories of economic-medicinal plants and natural habitat for wildlife (Meher Homji 1997). As discussed earlier, Sriharikota too has a history of clearing of native vegetation to raise fast growing or commercially important species for afforestation, shelter-belts, stabilising sand dunes, and revenue and employment generation. Studies in Sriharikota have

confirmed the deleterious impact of plantations on birds (David *et al.* 1998; Rao 1998; Manakadan and Sivakumar 2004a), besides mammals (Manakadan and Sivakumar 2004a), herpetofauna (Sivakumar and Manakadan 2004) and butterflies (Sivakumar *et al.* 2004). Fortunately, the earlier practice of clearing the native vegetation to raise plantations has stopped after BNHS representations to SDSC-SHAR and plantations are now raised in open scrub or sandy area. Another positive outcome has been the ban on raising new eucalyptus plantations.

### Invasives

Chilean Mesquite *Prosopis chilensis* and Cane *Calamus rotang* are major invasive plant species in Sriharikota. The Chilean Mesquite, an exotic from South America, has proliferated on its own in areas that faced clearing in the past and where the soils are saline (mostly in areas bordering Pulicat lake). Forestry experts need to be consulted on ways to eradicate this species as it has come up again in the same areas where they were eradicated earlier through uprooting and burning on a number of occasions. From our observations, species that can probably be planted after removal of Mesquite appear to be *Lansea coromandelica* and *Salvadora persica*, as both these species occur in saline soil areas. Another strategy could be to target *Prosopis* dominated areas for expansion of the spaceport. Cane, introduced during the British Era, has now spread and engulfed most of the freshwater streams and ponds, and their margins eliminating native vegetation. SDSC-SHAR has started large-scale commercial exploitation of cane in recent years and this may help check its spread. However, there is a need to directly deal with the problem in areas that have been totally engulfed with cane. Another invasive that is now seen in the residential and office compounds of Sriharikota is *Lantana camara*, which is a major problem in many forests tracts of India. Once established, it forms a dense shrub layer preventing other plants from surviving. Steps must be taken to weed out the species from the Island and not introduce it into residential areas, gardens and parks.

### Expansion of the spaceport

The developmental activities and expansion plans of the SDSC-SHAR have been making demands on the land. Large tracts of land were taken over by the spaceport for construction of a number of new buildings, facilities and for a new launch pad in recent years. Though acquisition of land for such purposes is unavoidable, measures could be taken up to lessen the impacts on the wildlife and their habitats such as (i) Acquiring land dominated by mesquite, eucalyptus and areas largely devoid of vegetation, (ii) Optimal use of

land for expansion plans and adopting landscape designing to retain as much of the native vegetation as possible around new facilities, and (iii) Demarcation of exclusive biodiversity conservation zones.

### CONCLUSION

With India's alarming biodiversity loss, especially in recent times, places like Sriharikota, with limited human intrusion, become significant for biodiversity conservation and could become more so in the future. It would not be wrong to assume that very little of the forest or wildlife of Sriharikota would have remained if ISRO had not taken over the Island. Sriharikota is very important from the biodiversity point of view as it has one of the last remaining, largest and best-preserved tract of the coastal Tropical Dry Evergreen Forest in India. Hence, we have recommended that the ISRO authorities at Sriharikota define the forest conservation and management policy in Sriharikota as: "All future efforts

towards the conservation of the wilderness areas of Sriharikota should aim at maintaining the natural biodiversity and helping it revert back to its pristine nature."

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LAND BIRDS OF SRIHARIKOTA ISLAND AND CONSERVATION ISSUES

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